Effects of Weed Control and Fertilization on Botanical Composition and Forage Yields of Kentucky Bluegrass Pasture

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Contents

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Effects of Weed Control and Fertilization on Botanical Composition and Forage Yields of Kentucky Bluegrass Pasture

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Weeds are undesirable in pastures because they use moisture, nutrients, and light that could be used by desirable forage species. Many weeds are unpalatable and are avoided by cattle; other weeds are eaten to some extent. Some that are eaten produce undesirable flavors in dairy products, may be poisonous, or cause mechanical injury to animals.

Based on the little information available, it is estimated that about 1 pound of desirable forage is lost for each pound of weeds produced (*11*, *12*).[2]

REVIEW OF LITERATURE

Weeds invade pastures that have deteriorated because management practices have reduced the vigor of the forage species. According to Brown (*4*), pastures deteriorate and are unproductive because of (1) low soil fertility, (2) harmful grazing, (3) diseases and insects, and (4) weather. Pastures are generally deficient in potassium, calcium, phosphorus, and nitrogen.

Most permanent pastures in the Northeastern United States are weedy and unproductive. Kentucky bluegrass (*Poa pratensis* L.) is generally the major grass species in these pastures. Both undergrazing and overgrazing may cause pastures to deteriorate and become weedy. Permanent pastures are generally grazed continuously from April to October or November. In the southern Corn Belt, cattle often are pastured the entire year. With continuous grazing, if the

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[2] Italic numbers in parentheses refer to Literature Cited, p. 27.

farmer stocks the pasture with enough animals to utilize the abundant growth of forage in May and June, the forage species will be overgrazed in the summer, fall, and early spring. On the other hand, if the pasture is stocked to assure enough grazing in midsummer, there will be surplus forage in May and June.

Carrier and Oakley (*5*) reported that under relatively heavy grazing, turf grasses became dense enough to keep weeds out, but under light grazing, forage was permitted to accumulate and pastures became weedy. Where winter annual weed grasses such as cheat (*Bromus secalinus* L.) and little barley (*Hordeum pusillum* Nutt.) are present, undergrazing in May and June permits these species to produce seed and thus perpetuates these weed problems.

Dense stands of ungrazed grass compete with legumes such as white clover (*Trifolium repens* L.), low hop clover (*T. procumbens* L.), and common and Korean lespedeza (*Lespedeza striata* (Thunb.) H. & A. and *L. stipulacea* Maxim.). If populations of legumes are reduced, nitrogen supplied to the grasses from legumes is reduced and deficiencies in nitrogen may occur. Competition from ungrazed forage in May and June hinders the establishment of lespedeza so that forage production from this legume is seriously reduced in July and August.

As surplus forage matures in June it becomes unpalatable and cattle tend to overgraze where mature forage has not accumulated. Further damage from overgrazing may occur by late-fall, winter, or early-spring grazing. Kentucky bluegrass makes most of its root and rhizome growth during the cool seasons of the year (*3*, *9*, *15*). If the amount of leaf tissue is continuously reduced by close grazing, production of food for growth of new roots and rhizomes will be reduced (*1*, *6*, *8*). Thus the plant will not be able to grow enough new rhizomes to thicken the sod or enough roots so that the plants will tolerate drought. These thin sods are easily invaded by weeds.

Compaction of the soil from grazing animals, although not widely recognized, may contribute to deterioration of the pasture. Serious compaction and cutting of sod have occurred where cattle have been grazed early in the spring when the soil was soft from winter frost and spring rains. Cattle grazing the short forage in early spring do considerable traveling to get a fill of grass and thus may trample large areas of the pasture. Sod thus disturbed is easily invaded by weeds.

Insects may also have a role in thinning sods so that weeds will invade. Kentucky bluegrass sods that are low in vigor because of poor fertility and poor grazing management are attractive to June beetles (*Phyllophaga* spp.). Graber et al. (*7*) reported that June beetles prefer to lay their eggs in overgrazed, thin-sodded bluegrass areas and tend to avoid ovipositing in dense stands of grass and legumes. Feeding larvae of June beetles may cut roots and rhizomes so extensively that large areas of sod may be killed.

Bluegrass webworms (*Crambus teterrellus* (Zicken)) feed on crowns of bluegrass, and extensive damage to grass on lawns and golf greens has been reported (*14*). They undoubtedly also damage Kentucky bluegrass pastures, but the extent of such damage has not been assessed.

Pastures that have been abused are especially susceptible to further damage by drought and heat. Kentucky bluegrass plants with poorly developed root systems, because of poor fertility and poor grazing management, are not able to obtain maximum amounts of moisture from the soil. Reductions of the root system by insects will further reduce the ability of the plant to obtain water.

Kentucky bluegrass has a shallow root system and therefore is limited in obtaining soil moisture. Karraker and Bortner (*10*) observed that most of the Kentucky bluegrass roots are in the surface 4 inches of soil and few are below 10 inches. Brown (*3*) found that when there was no rain for 2 weeks during the summer, moisture in a healthy bluegrass sod decreased from a surplus to a deficit. He (*2*) also showed that bluegrass grew very little at 65° to 75° F. The interactions of low fertility, poor management, insects, and growth characteristics cause Kentucky bluegrass sod to become so thin that weed seedlings easily become established.

PURPOSE OF STUDY

Although it is well known that spraying with 2,4-D will reduce weed infestations, information is inadequate on the quantitative improvement of pasture from this herbicide. Fertilization will increase the stand of desirable forage, but little information is available on the effects of fertilizers combined with the weed-control practices of spraying and mowing. Much of the information on fertilization was obtained on pastures managed to maintain high vigor of the forage species, but little information is available on the effects of these treatments on pastures so poorly managed that the vigor of the forage species is reduced.

Since many pastures in the southern Corn Belt are poorly managed, it is important to find out how much improvement can be realized on an average farmer-managed pasture when fertilizer is used with 2,4-D or mowing. The purpose of this study was to determine the effects of 2,4-D and mowing, each combined with three fertilizer levels, on the botanical composition and desirable forage production of a Kentucky bluegrass pasture.

MATERIALS AND METHODS

The experiment was conducted on a farm pasture 4 miles east of Columbia, Mo. This pasture was selected because the weed infestation, conditions of the turf, and the management were typical of many pastures in the southern Corn Belt. The soil was Mexico silt loam with a 3- to 4-percent slope. Several gullies were in the pasture, and some erosion was taking place. The area had been cropped until 1934, when it was planted to corn, and it has been pastured since 1935. Rock phosphate was applied to the area while it was in pasture, but no other fertilizer or lime had been used.

The pasture was grazed continuously by a beef cow-calf herd. It was overgrazed during most of the year except in May and June, when excessive forage accumulated. This consisted of mature Kentucky bluegrass, high proportions of cheat, and some little barley. Low hop clover was abundant in the spring of some years. Because Korean lespedeza was sparse in the area before the experiment was started, it was drilled into the soil on April 19 to 23, 1962, at 30 pounds per acre. After failing to get a stand from the first sowing, it was resown in March 1963.

Broadleaf weed species present were predominantly horseweed (*Erigeron canadensis* L.), rough fleabane (*Erigeron strigosus* Muhl.), lanceleaf ragweed (*Ambrosia bidentata* Michx.), red sorrel (*Rumex acetosella* L.), common yarrow (*Achillea millefolium* L.), western ironweed (*Vernonia baldwini* Torr.), and some late eupatorium (*Eupatorium serotinum* Michx.). Previous to the experiment the pasture had been mowed annually, but usually too late in the summer to prevent seed production of most species, except western ironweed and late eupatorium.

The experiment was a factorial design with weed control and fertility as the two sets of variables. The weed-control treatments consisted of (1) 1 pound per acre of 2,4-D amine applied approximately on June 11 each year from 1962 to 1965, (2) annual mowing at the same time 2,4-D was applied, and (3) no weed control. These treatments were applied in combination with low-, medium-, and high-fertility treatments. In the low-fertility treatment no lime or fertilizer was applied. The medium- and high-fertility treatments consisted of 4 tons per acre of lime applied in April 1962 to bring the pH from 5.6 to about 6.5. Plots of the medium treatment also received 100 pounds per acre of 0-25-25 in April 1962 and each March from 1963 to 1966. Plots of the high-fertility treatment received 400 pounds per acre of 22-11-11 in April 1962, then 60 pounds per acre of nitrogen as ammonium nitrate and 100 pounds of 0-25-25 in late March of each year from 1963 to 1966. All lime and fertilizer were applied to the surface.

The medium-fertility level was considered optimum to maintain a bluegrass-lespedeza pasture. Nitrogen fixed by the lespedeza was assumed to be adequate to supply the bluegrass in the mixture.

For comparison, a plot was included in each replication that had been plowed and sown to a mixture of orchardgrass (*Dactylis glomerata* L.) and ladino clover (*Trifolium repens* L.). These plots were fertilized with 700 pounds per acre of 14-28-14 and 4 tons of lime in April 1962. In March 1965 and 1966, 60 pounds per acre of nitrogen were applied as ammonium nitrate. These plots were fenced and rotationally grazed. Cattle were permitted to graze at intervals of 4 to 5 weeks. Each grazing period lasted from 7 to 10 days. Cattle were removed when they had eaten most of the forage.

Each plot was 30 by 170 feet and treatments were replicated four times. The weed infestation and forage density were evaluated in late May of each year. Broadleaf weeds were counted and the cover of weed grasses and forages was estimated in 2- by 4-foot quadrats. The quadrats were placed at 15-foot intervals along a transect running diagonally across each plot. A steel tape was used to mark the transect and measure the distance between quadrats. The starting points for the first quadrats were selected at random and were recorded so that the quadrats were put in the same place each year. With this method yearly changes could be recorded in the botanical composition of the pasture. Since the quadrats did not include a large enough sampling of the western ironweed population, ironweed stems and clumps were counted in a 10- by 170-foot strip extending through the center of each plot.

Forage production and consumption were measured with the paired cage method described by Klingman et al. (*13*). A sample area was randomly located and a similar adjacent area was selected. A coin was flipped to determine which of the two areas would receive the cage. The other area was marked with a piece of rubber inner tube, 1 inch by about 6 inches, which was anchored to the soil with a long nail. Forage was clipped from a 4- by 4-foot section in the center of each 5- by 5-foot cage and in each selected adjacent area. It was harvested at intervals of approximately 1 month except during dry weather in July and August of some years, when the intervals between harvest extended to 6 or 8 weeks. The first harvest was in May and the last one in October of each year. The clipped vegetation was ovendried and weighed. Weight of forage from the adjacent area was subtracted from the weight of forage from the cage to determine the amount the cattle had consumed.

Each dried forage sample was spread on a table, and two men visually estimated the percentage that each botanical component contributed to the weight of the sample. These percentages were used to determine the yield and consumption of broadleaf weeds, weed grasses, sedges, legumes, and Kentucky bluegrass or orchardgrass. Some of the samples were hand separated into various botanical components to aid in estimations. Estimates were usually within 5 to 10 percent of the actual composition and were considered accurate enough to detect important differences. The weight of each botanical component from the uncaged sample was subtracted from the weight of the same botanical component inside the cage to determine the consumption of that component. Total production of each component for each year was calculated by adding the yield outside the cage at the last harvest to the total consumption for the year.

RESULTS AND DISCUSSION

The forage density and weed populations changed somewhat from year to year owing to environmental conditions. Because of dry weather in the early spring of 1962, lespedeza failed to produce a stand. Dry weather in 1962 also may have reduced the population of ragweed and other annual weeds. Lespedeza germinated and grew well in 1963, 1964, 1965, and 1966. Moisture was abundant in 1965 and an especially heavy stand of ragweed developed.

Orchardgrass and ladino clover failed to become established on the renovated plots in the spring of 1962, and the plots were replanted in August 1962. A dense stand of orchardgrass, with almost no ladino clover, was present on the renovated plots in the spring of 1963. Some ladino clover appeared in the spring of 1964 but soon died from drought.

Weeds were counted in late May of each year before the plots were sprayed or mowed, and therefore the populations listed reflect the effects of treatments applied in previous years. Spraying or mowing either eliminated or reduced the seed production so that subsequent stands of annual weeds originated largely from weed seed that had been dormant in the soil or perhaps was moved in from adjacent plots. Since cheat and Kentucky bluegrass were undergrazed, growth accumulated in May and June, but during midsummer and late summer the pasture was overgrazed.

Weed Populations

Horseweed and Rough Fleabane

These species were grouped together when data were taken because horseweed is closely related to and difficult to distinguish from rough fleabane.

The populations of horseweed and rough fleabane fluctuated considerably from year to year as shown in figure 1. Spraying with 2,4–D significantly reduced the populations in 1963, 1964, and 1965 as compared with the population in the check plots. Mowing also reduced horseweed and rough fleabane populations, but not to the same extent as did 2,4–D. The difference in results between spraying and mowing was probably because 2,4–D killed many of the plants and injured the remaining ones so that seed production was prevented, whereas plants that were mowed were able to produce some seed from branches that regrew or escaped mowing.

Fertilizers did not significantly affect the population. For some unexplained reason horseweed and rough fleabane populations were low on all plots in 1966 and there were no differences in populations due to treatments. Dry periods in the late summer and fall of 1965, when the horseweed and rough fleabane were germinating, may have reduced the populations.

Lanceleaf Ragweed

Lanceleaf ragweed populations were not significantly reduced by weed-control treatments until after three annual treatments (fig. 1). In 1965 significantly fewer ragweed plants were present on plots treated with 2,4–D or mowed. By 1966 the sprayed plots had significantly fewer plants than did the mowed plots.

In 1964 and 1966, plots receiving high-fertility treatments had significantly fewer ragweed plants than did plots with no fertility treatments. High fertility evidently increased the density of Kentucky bluegrass and weed grasses so that their competition reduced the number of ragweeds that were able to survive. Fertility treatments had no effect on ragweed populations where mowing and 2,4–D had already reduced the population, but where no weed-control treatments were used, 4 years of fertility treatment substantially reduced the population (fig. 2).

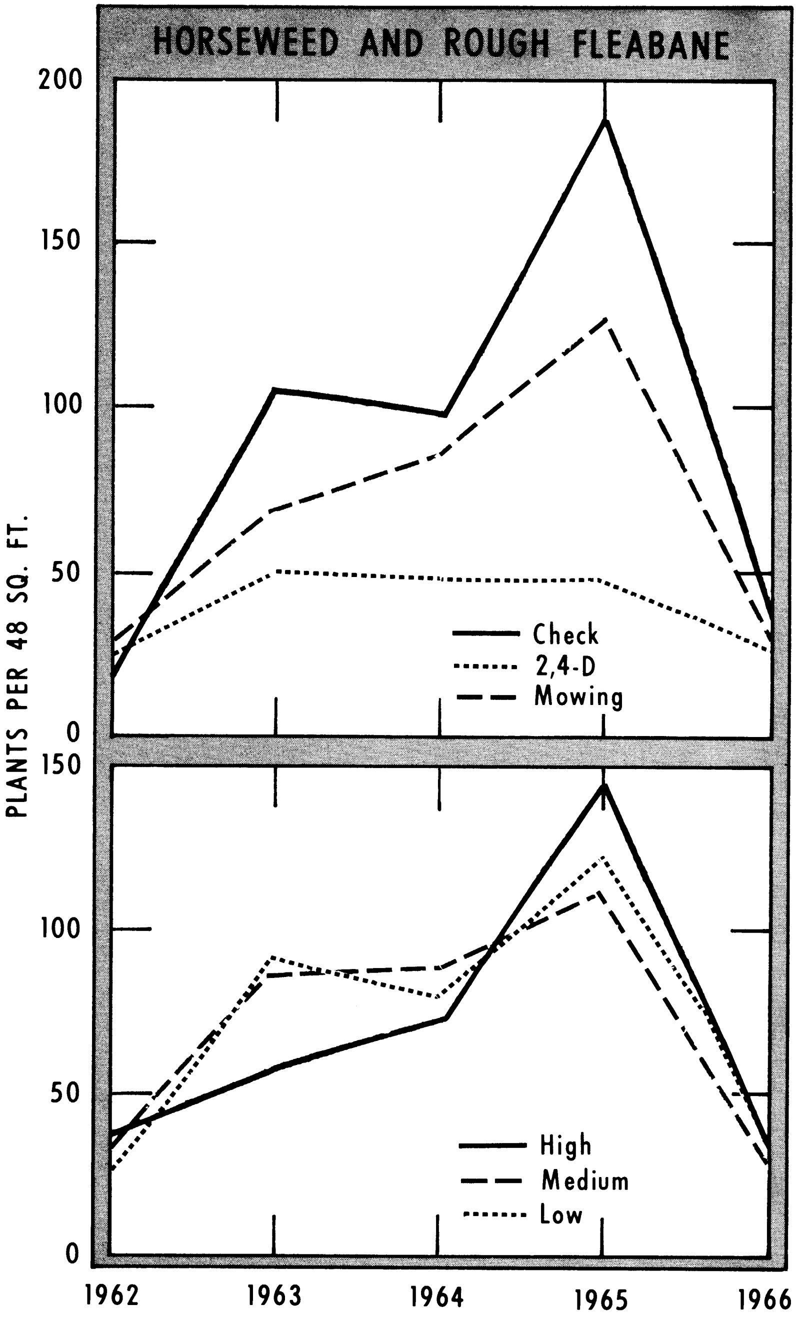


FIGURE 1.—Effects of weed-control (top) and fertility (bottom) treatments on various weed populations, 1962–66.

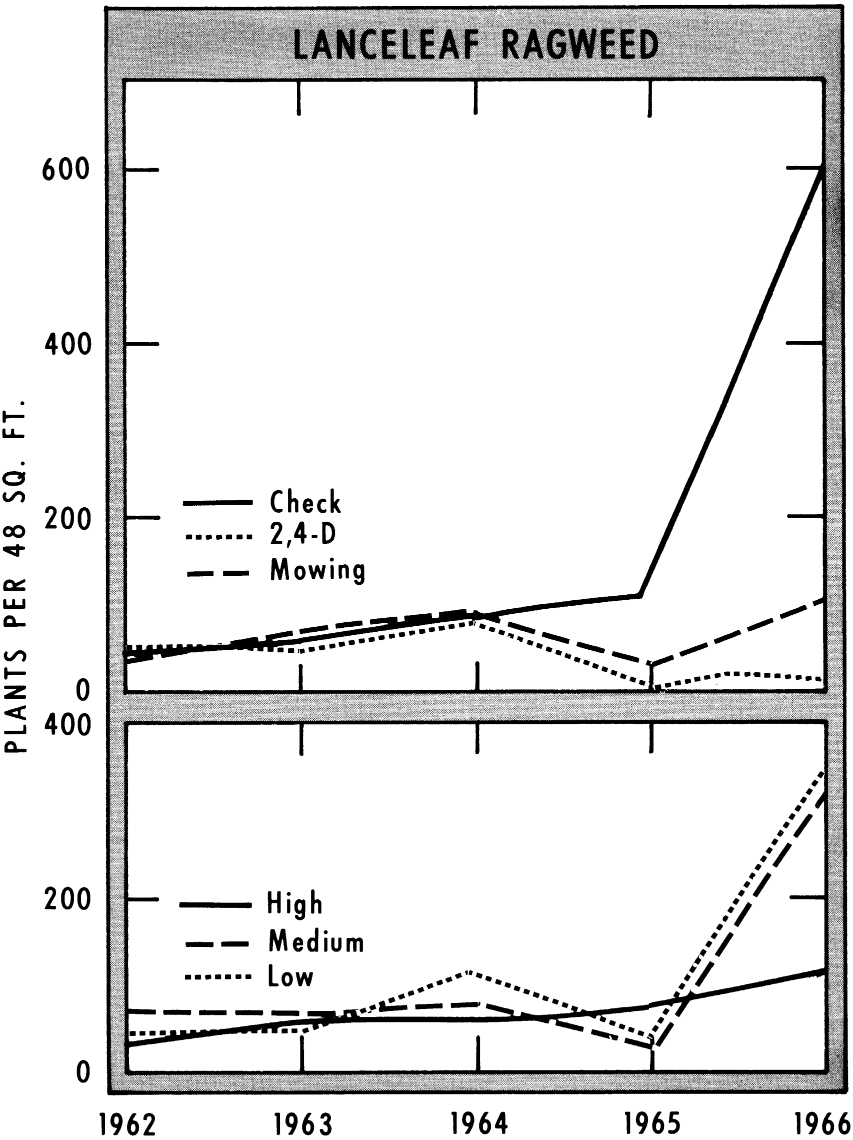
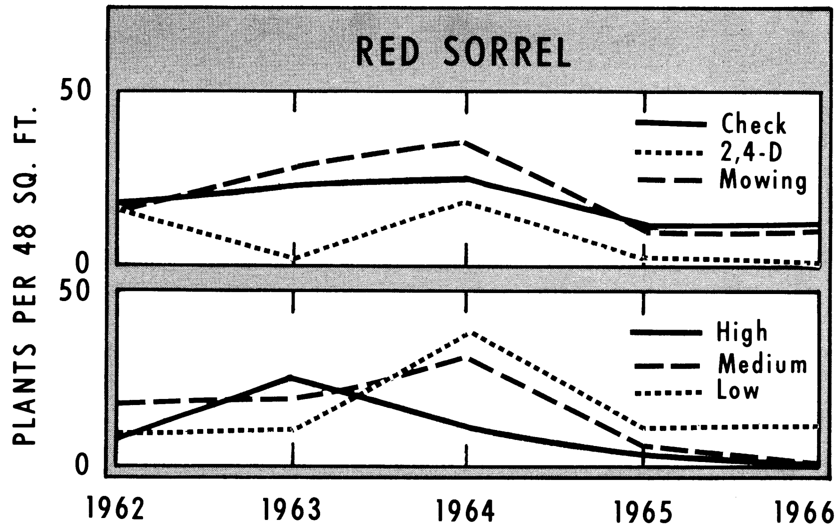


FIGURE 1.—Effects of weed-control (top) and fertility (bottom) treatments on various weed populations, 1962–66—Continued.



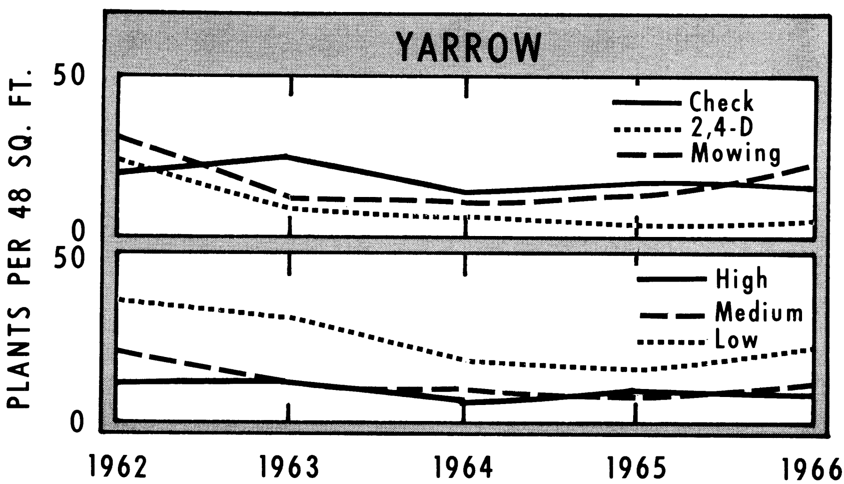


FIGURE 1.—Effects of weed-control (top) and fertility (bottom) treatments on various weed populations. 1962–66—Continued.

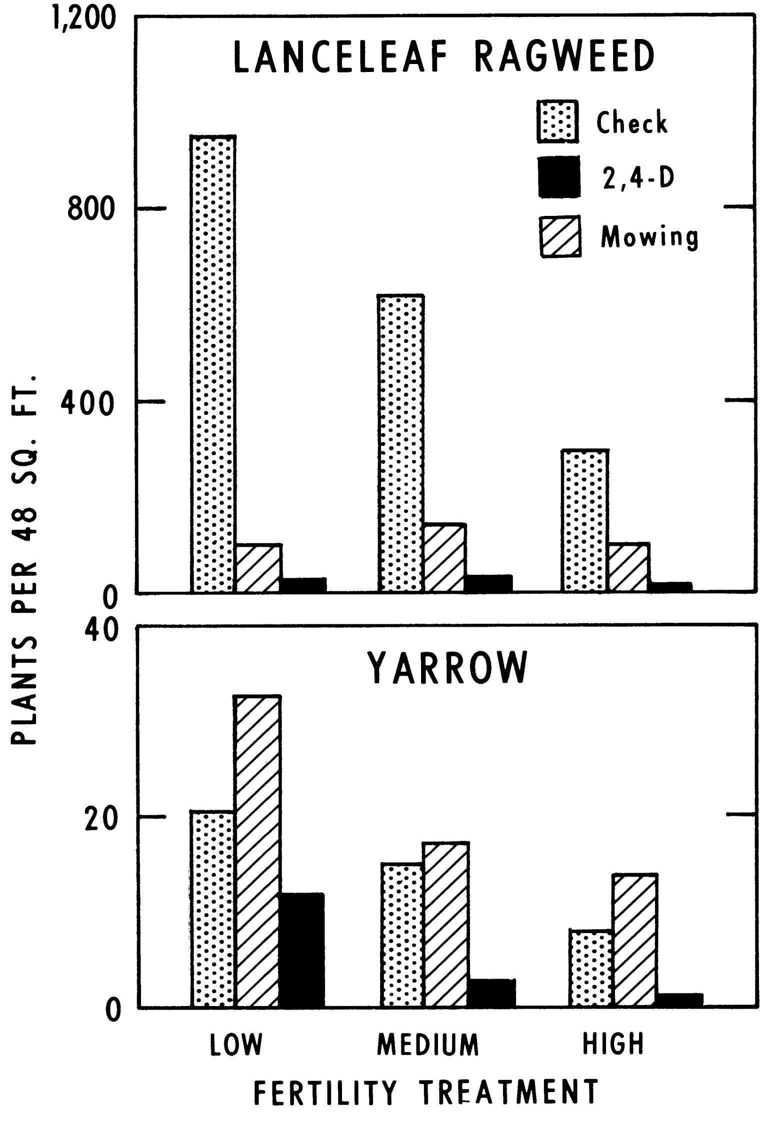


FIGURE 2.—Effects of 4 years of weed-control and fertility treatments on lanceleaf ragweed and yarrow populations, 1966.

Red Sorrel

The red sorrel population was significantly reduced in 1963 and 1965 by 2,4–D (fig. 1).

High-fertility treatments significantly reduced the population in 1964, 1965, and 1966, and medium-fertility treatments also reduced it in 1965 and 1966. High fertility increased the density and production of grass species so their competition may have reduced the red sorrel population. Medium fertility increased the competition from legumes, which may have reduced the red sorrel stand.

Yarrow

Spraying with 2,4–D significantly reduced the yarrow stand in 1963, 1964, 1965, and 1966, but mowing did not reduce this perennial weed (fig. 1).

Yarrow plants decreased on plots receiving high-fertility treatments. The interaction of 2,4–D and high fertility almost eliminated yarrow from the plots (fig. 2).

Western Ironweed

The western ironweed stems were counted in 1962. In subsequent years they were counted and the percent remaining were calculated based on the 1962 stand.

Spraying with 1 pound per acre of 2,4–D amine significantly reduced the number of ironweed stems each year until only 1 percent remained in 1965 and 1966 (fig. 3). Mowing reduced the number to some extent each year until 40 percent of the stems remained in 1966; however, stems in the check plots had declined to 80 percent of the original.

Fertility treatments neither increased nor decreased the number of stems.

Late Eupatorium

A few late eupatorium plants were present at the start of the experiment, but many seedlings appeared during the wet summer of 1965. The 1965 data in table 1 were taken in the spring before seedlings appeared. In 1966 many mature plants were present. 2,4–D was not effective on late eupatorium. Fewer plants were present on plots mowed annually than on plots treated otherwise because less seed was produced on the mowed plots. Some seed evidently blew in from adjacent areas and accounts for an increase in plants from 1965 to 1966 on the mowed plots. Eupatorium seed is easily blown by the wind because it has a feathery pappus.

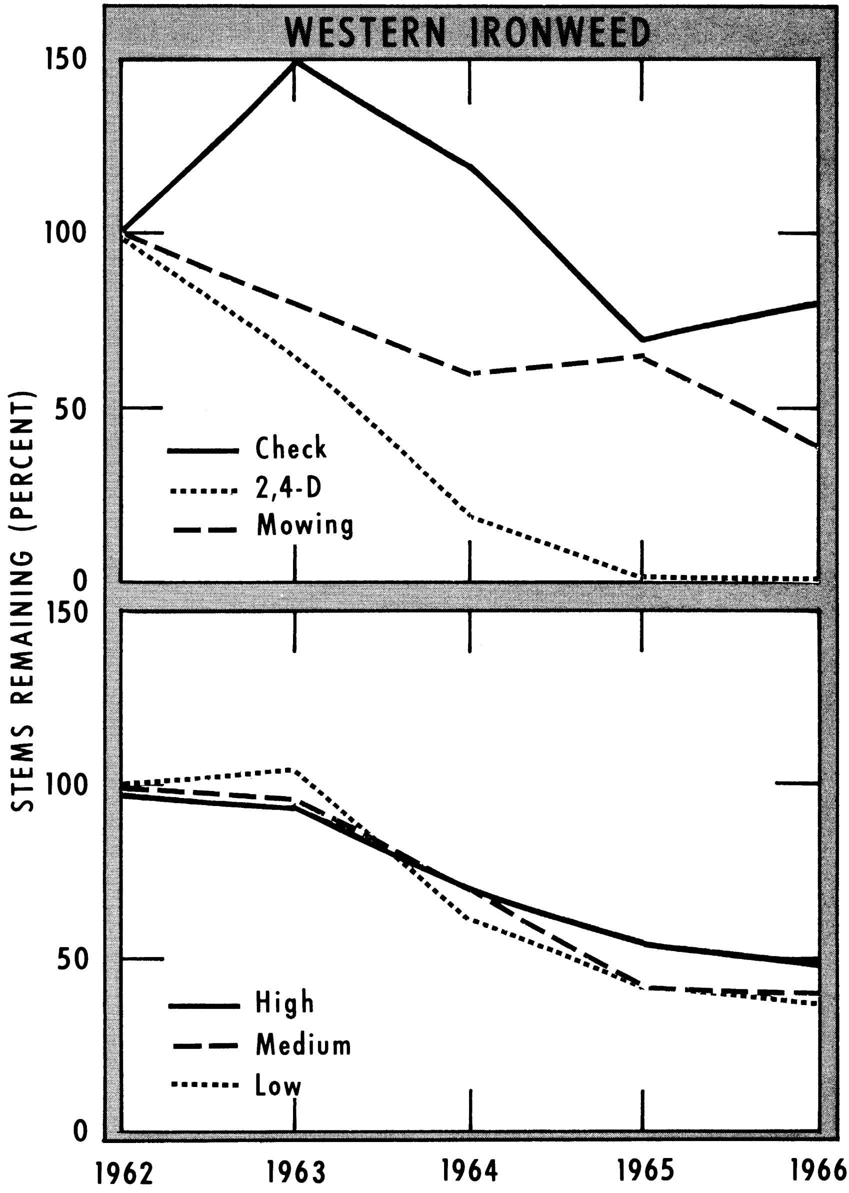


FIGURE 3.—Effects of weed-control (top) and fertility (bottom) treatments on amount of western ironweed stems, 1962–66.

TABLE 1.—*Late eupatorium populations as affected by weed-control and fertility treatments, 1965 and 1966* [1]

Treatment	Plants per 1,700 square feet	
	1965	1966
Weed control:	*Number*	*Number*
Check	24a	111a
2,4–D	12a	78ab
Mowing	20a	40b
Fertility:		
Low	19a	80a
Medium	18a	81a
High	20a	67a

[1] Data taken in late May before spraying and mowing. Numbers with same letters do not differ significantly at 5-percent probability level according to Duncan's multiple range test.

Ground Cover

In late May of each year when the estimates of ground cover were made, the legume component consisted largely of low hop clover and a small percentage of young lespedeza seedlings.

The cover of broadleaf weeds decreased from year to year on plots treated with 2,4–D or mowed (table 2). The high-fertility treatment in April 1962 caused the Kentucky bluegrass cover to increase by late May of the same year (table 3). Dry weather during the summer of 1962 reduced the bluegrass in the spring of 1963, but favorable moisture increased it in 1964. During the 5-year experiment the bluegrass cover was greater on plots receiving the high-fertility treatments. Removal of weeds with 2,4–D plus the high-fertility treatment interacted so that the bluegrass on these plots was significantly greater than on the other treated plots (table 3).

TABLE 2.—*Amount of ground covered by broadleaf weeds as affected by weed-control and fertility treatments, 1962–66* [1]

Treatment	1962	1963	1964	1965	1966
Weed control:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Check	39a	33a	22a	21a	25a
2,4–D	38a	17b	12b	4b	3b
Mowing	39a	26a	19a	17ab	9b
Fertility:					
Low	43a	26a	22a	14a	16a
Medium	40a	26a	18ab	14a	12a
High	34a	25a	13b	14a	10a

[1] Data taken in late May before spraying and mowing. Numbers with same letters do not differ significantly at 5-percent probability level according to Duncan's multiple range test.

TABLE 3.—*Amount of ground covered by Kentucky bluegrass as affected by weed-control and fertility treatments, 1962–66* [1]

Treatment	1962	1963	1964	1965	1966
Check:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Low fertility	30b	7c	16d	11c	14d
Medium fertility	34b	12bc	27abcd	19abc	18cd
High fertility	47a	16abc	37ab	21abc	27bc
2,4–D plus—					
Low fertility	33b	15abc	28abcd	25a	26bc
Medium fertility	25b	10c	24abcd	23ab	27bc
High fertility	42a	21ab	42a	38a	48a
Mowing plus—					
Low fertility	32b	15abc	20cd	14abc	17cd
Medium fertility	24b	10c	21cd	12bc	19cd
High fertility	47a	25a	35abc	23ab	31b
Averages: [2]					
Main effects of weed control:					
Check	37a	12a	27a	17b	20b
2,4–D plus fertility	33a	15a	32a	29a	34a
Mowing plus fertility	34a	13a	25a	16b	22b
Main effects of fertilizer:					
Low fertility	32b	12a	21ab	17ab	19b
Medium fertility	28b	11a	24ab	18b	21b
High fertility	44a	21a	38a	27a	35a

[1] Data taken in late May before spraying and mowing. Numbers with same letters do not differ significantly at 5-percent probability level according to Duncan's multiple range test.

[2] In first 3 entries, averages include data for low plus medium plus high fertility treatments (ex. mowing plus fertility for 1962 is $32 + 24 + 47 \div 3 = 34$); in last 3 entries, averages include data for fertility treatment alone (check), 2,4–D plus fertility, and mowing plus fertility (ex. low fertility for 1962 is $30 + 33 + 32 \div 3 = 32$).

The effects of 4 years of treatments on the amount of ground covered by various botanical components are shown in figure 4. Four years of spraying with 2,4–D reduced the broadleaf weed competition so that cover of Kentucky bluegrass and especially the legumes increased. Even though 2,4–D caused injury symptoms on the legumes, the legumes were able to increase on plots receiving low- and medium-fertility treatments. Four years of mowing also decreased the cover of broadleaf weeds and increased the cover of legumes. Mowing had little effect on the cover of Kentucky bluegrass.

Four years of fertility treatments had little effect on the cover of sedges and weed grasses. The high-fertility treatment tended to decrease the cover of broadleaf weeds. The cover of legumes increased

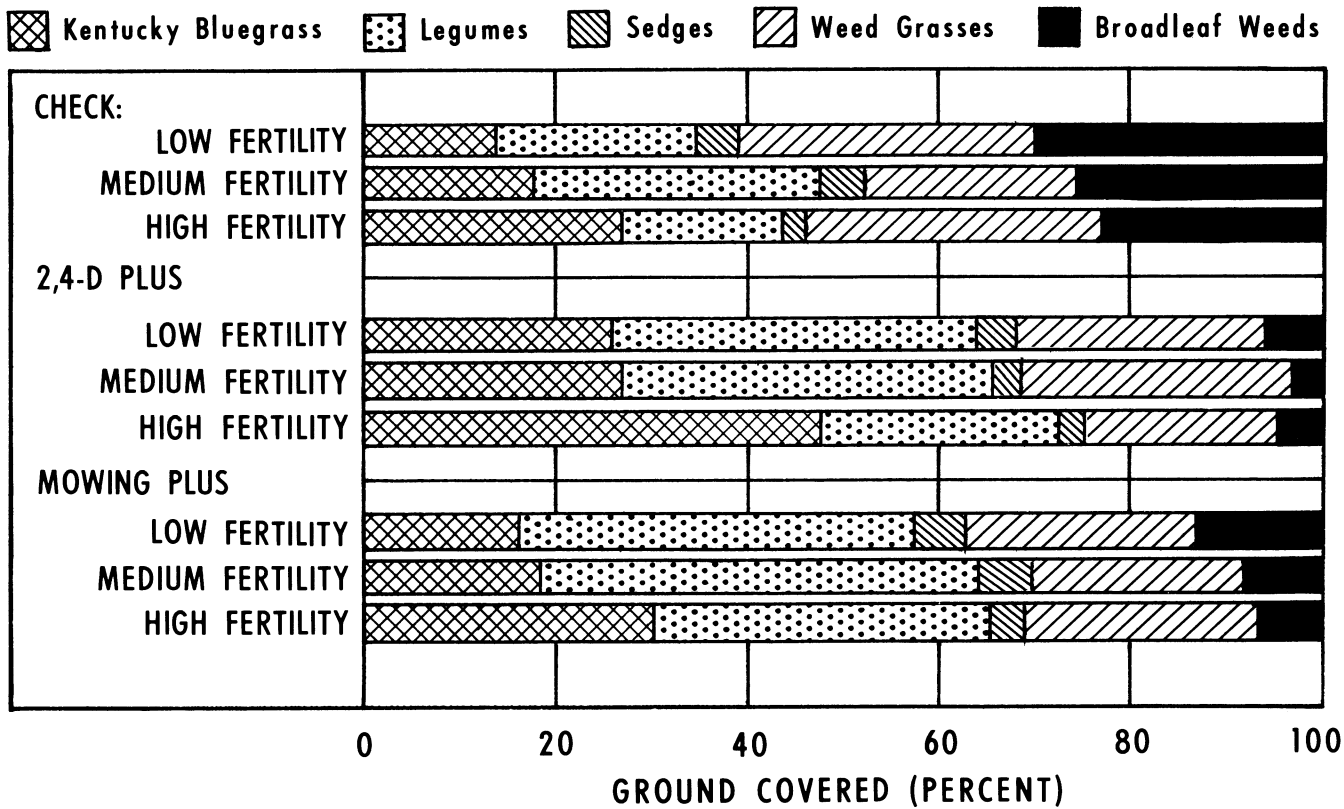


FIGURE 4.—Effects of 4 years of weed-control and fertility treatments on amount of ground covered by various botanical components on Kentucky bluegrass pasture plots, May 1966.

under the medium-fertility treatment, but it decreased under high fertility.

Figure 5, *A*, shows the abundant growth of western ironweeds, lanceleaf ragweeds, and other species characteristic of the flora on untreated bluegrass plots. After four annual sprayings the weed populations were reduced so that the pasture was much improved in appearance and had higher proportions of desirable forage species (fig. 5, *B*). Mowing also improved the appearance of the plots and prevented or reduced seed production, but the perennial weeds were only slightly reduced after four annual mowings (fig. 5, *C*).

Forage Production

Treatment with 2,4-D reduced the average production of broadleaf weeds to 88 pounds per acre compared with 329 pounds on mowed plots and 950 pounds on untreated plots (table 4). Differences in yields on sprayed and mowed plots are largely because 2,4-D killed perennial weeds to a greater extent than did mowing. Mowing reduced seed production and subsequent regeneration of weed stands, but not to the same extent as did spraying. Both medium- and high-fertility treatments tended to suppress broadleaf weed production, but not significantly.

Mowed plots tended to have lower yields of weed grasses than the 2,4-D or untreated plots. Mowing apparently reduced seed production to some extent and thus reduced the amount of reinfestation. The nitrogen used in the high-fertility treatments increased the yield of weed grasses.

None of the treatments significantly affected production of sedges.

The greatest production of legumes occurred on the mowed plots, probably because mowing reduced the competition of weeds with lespedeza, hop clover, and white clover. Legume production on plots treated with 2,4-D was greater than that on the check plots, but less than that on the mowed plots. The herbicide directly injured the legumes to some extent, especially the white clover present in wet years, but indirectly increased yields of legumes by reducing weed competition.

Plots with the medium-fertility treatment yielded significantly more legumes than plots with the high-fertility treatment. The nitrogen in the latter treatment increased the yields of both weed grasses and Kentucky bluegrass and thus caused greater competition to the legumes.

Production of Kentucky bluegrass was significantly better on plots that received 2,4-D largely because of the reduced competition from

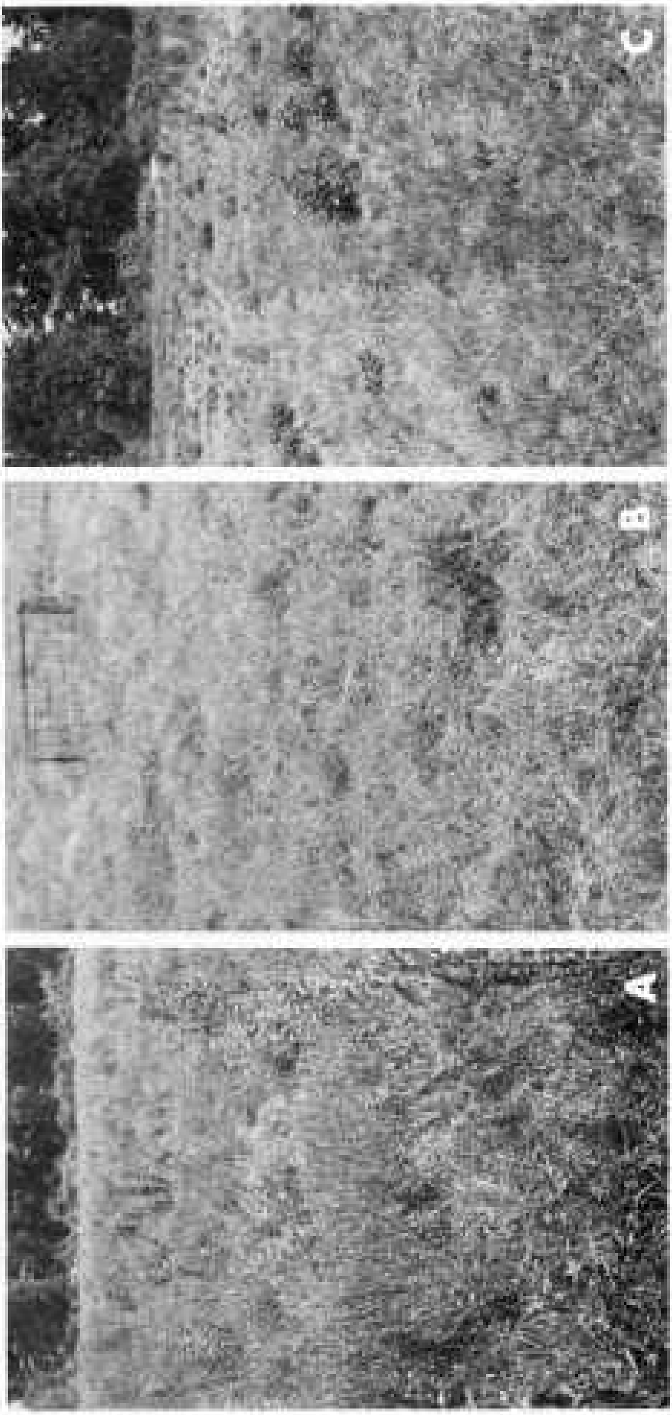


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FIGURE 5.—Kentucky bluegrass pasture plots in early August 1965: *A*, Check; *B*, after four annual sprayings with 2,4-D; *C*, after four annual mowings.

TABLE 4.—*Average annual production and consumption per acre of various botanical components on Kentucky bluegrass and orchardgrass plots as affected by different treatments during 4-year period* [1]

Plot and treatment	Broadleaf weeds	Weed grasses	Sedges	Legumes	Forage grass	Total forage
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
			PRODUCTION PER ACRE			
Bluegrass:						
Weed control:						
Check	950a	864ab	60a	295c	900b	3,069a
2,4–D	88c	925a	45a	467b	1,156a	2,681b
Mowing	329b	678b	52a	670a	927b	2,656b
Fertility:						
Low	529a	781b	76a	475b	810b	2,671b
Medium	408a	777b	55a	579a	857b	2,676b
High	422a	907a	55a	339bc	1,305a	3,028a
Plowed and sown to orchardgrass [2]	184	11	0	64	3,940	4,199
			CONSUMPTION PER ACRE			
Bluegrass:						
Weed control:						
Check	463a	782a	122a	206c	781b	2,354a
2,4–D	32c	822a	133a	449b	1,034a	2,470a
Mowing	255b	648a	25b	614a	857b	2,399a
Fertility:						
Low	279a	725a	67a	450b	749b	2,270b
Medium	194a	722a	72a	556a	761b	2,305b
High	260a	858a	46a	327c	1,169a	2,660a
Plowed and sown to orchardgrass [2]	12	10	0	59	3,815	3,896

[1] Based on ovendried forage and averages for 1962, 1963, 1965, and 1966; 1964 data omitted because cattle got into cages and consumed some of the forage. Yields with same letters do not differ significantly at 5-percent probability level according to Duncan's multiple range test.

[2] Average for 1963–66 (not comparable to bluegrass data).

broadleaf weeds. The nitrogen used on plots of the high-fertility treatments significantly increased yields of Kentucky bluegrass as compared with yields for the other fertility treatments, which were nearly equal.

Because of the large amount of broadleaf weeds on untreated plots, the average total production of vegetation was significantly greater than on plots with weed-control treatments. The increased production of weed grasses and Kentucky bluegrass from the high-fertility treatment caused the total forage production to be significantly greater on these plots than on plots with low- or medium-fertility treatments.

The interaction of 2,4-D and high-fertility treatments caused the highest production of Kentucky bluegrass (fig. 6). Some stimulation of Kentucky bluegrass production occurred on all plots treated with high fertility, but the highest production occurred on plots where high fertility was used and weeds were controlled with either 2,4-D or mowing. The combination of high fertility and 2,4-D reduced the yields of legumes, perhaps because of increased competition by grass. When no weed-control treatments were used, fertility treatments had little effect on yields of components other than Kentucky bluegrass and weed grasses.

Forage Consumption

The data show that on some plots the cattle consumed more than half of the broadleaf weeds produced (table 4 and fig. 6). However, the method of sampling caused the consumption of broadleaf weeds to be considerably exaggerated. As the weeds became mature and brittle toward the end of the summer, much of the vegetation was broken by the trampling cattle and lost rather than consumed; thus, especially at the time of the last harvest, the difference between the amount of forage inside and outside the cages represented the amount consumed plus the amount lost.

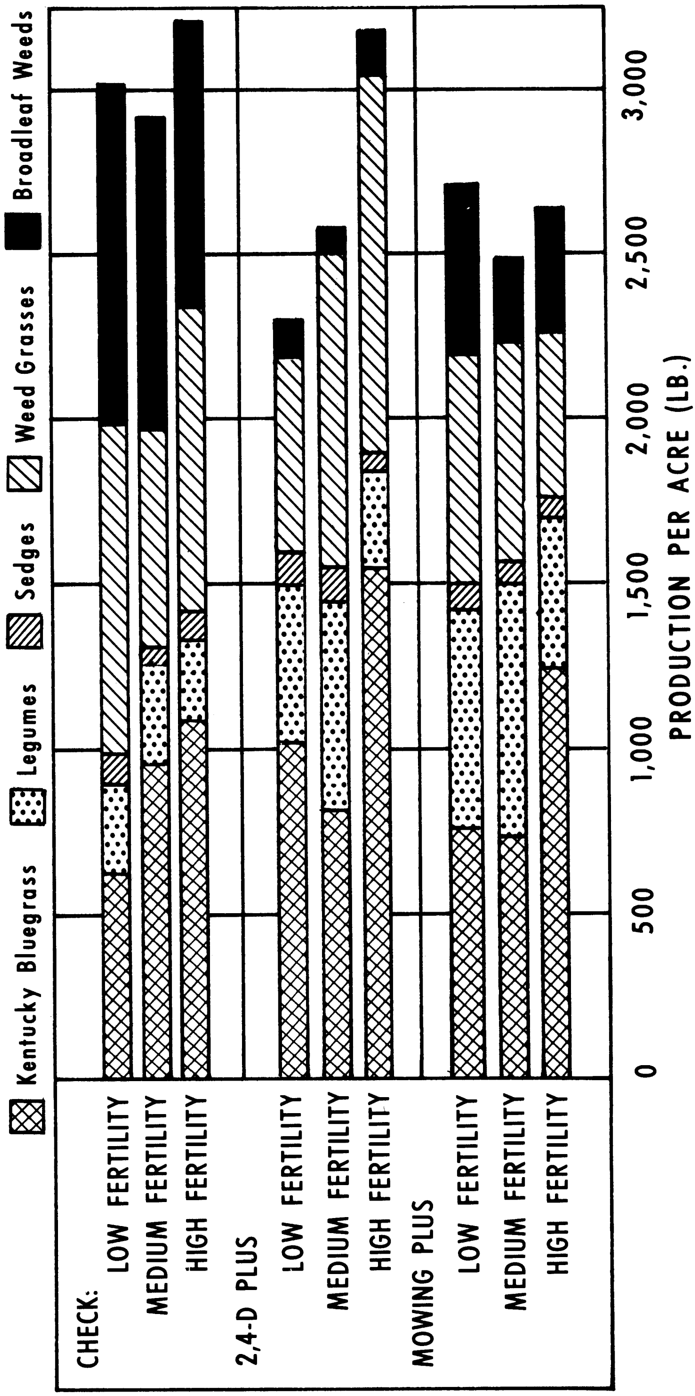
Observation of the grazing animals showed that they consumed the upper parts of *Erigeron* sp. and some ragweed. When ragweed was small, it was assumed that some of it was accidentally consumed along with Kentucky bluegrass and legumes; however, tops missing from older ragweed plants indicated that parts of this weed were consumed intentionally. It is doubtful, however, that the cattle consumed more than 10 percent of the broadleaf weeds produced. About 80 to 90 percent of the production of weed grasses, sedges, legumes, and Kentucky bluegrass was consumed at the end of the season in the fall. Because the cattle were not able to consume all the forage produced in May and June, Kentucky bluegrass and cheat matured and became unpalatable, but as the season progressed, lespedeza was grazed and much of the mature forage was consumed along with the lespedeza. However, some of the cheat probably was also lost rather than consumed as the data on weed grasses indicate.

Because the amounts of broadleaf weeds actually consumed appear to be almost negligible, we will consider only Kentucky bluegrass, legumes, and weed grasses as edible forage. Where no weed-control treatments were used, the medium-fertility treatment (phosphorus and potassium) did not increase the average amount of edible forage consumed, but the high-fertility treatment (nitrogen, phosphorus, and potassium) increased the consumption about 300 pounds per acre (fig. 6). The low-fertility treatment with 2,4-D increased consumption about 200 pounds per acre, but the medium and high levels with this herbicide increased consumption about 600 and 1,000 pounds per acre, respectively. Mowing was not so effective as 2,4-D for controlling weeds, but fertilizers increased the consumption of edible forage about 200 pounds per acre on mowed plots. Under the medium-fertility treatment where 2,4-D was used, consumption of legumes increased considerably, but under the high-fertility treatment, consumption of legumes declined and consumption of both Kentucky bluegrass and weed grasses increased considerably. Consumption of legumes increased with mowing plus low and medium fertility, but where nitrogen was used in the high-fertility treatment, consumption of grasses increased at the expense of legumes.

Renovated Plots

The orchardgrass plots were free of weeds in 1963 and 1964, probably due to the manner in which the seedbed was prepared. Because the weed seeds in old pasture sods are usually at or near the surface, the sod was turned over with a plow and disked shallow so that few weed seeds were brought to the surface of the seedbed. Numerous late eupatorium and lanceleaf ragweed seedlings were present in the plots in 1965 and 1966. The change in weed infestation of the plots between 1963 and 1966 is shown in figure 7 and table 5.

Production of orchardgrass decreased from 5,654 pounds per acre in 1963 to 2,690 pounds in 1964, because legumes failed to become established and the orchardgrass lacked nitrogen. Because the orchardgrass plants had very little top growth to protect them from the frost during the winter of 1964 and 1965, the stand was noticeably thinned in the spring of 1965. Sixty pounds per acre of nitrogen as ammonium nitrate, applied in March of 1965 and 1966, corrected the nitrogen deficiency so that the orchardgrass recovered and produced 4,567 pounds per acre in 1966. Thinning of the stand in 1964 caused open spots where weed seedlings easily became established.


Kentucky Bluegrass
Legumes
Sedges
Weed Grasses
Broadleaf Weeds
CHECK:
LOW FERTILITY
MEDIUM FERTILITY
HIGH FERTILITY
2,4-D PLUS
LOW FERTILITY
MEDIUM FERTILITY
HIGH FERTILITY
MOWING PLUS
LOW FERTILITY
MEDIUM FERTILITY
HIGH FERTILITY
0
500
1,000
1,500
2,000
2,500
3,000
PRODUCTION PER ACRE (LB.)

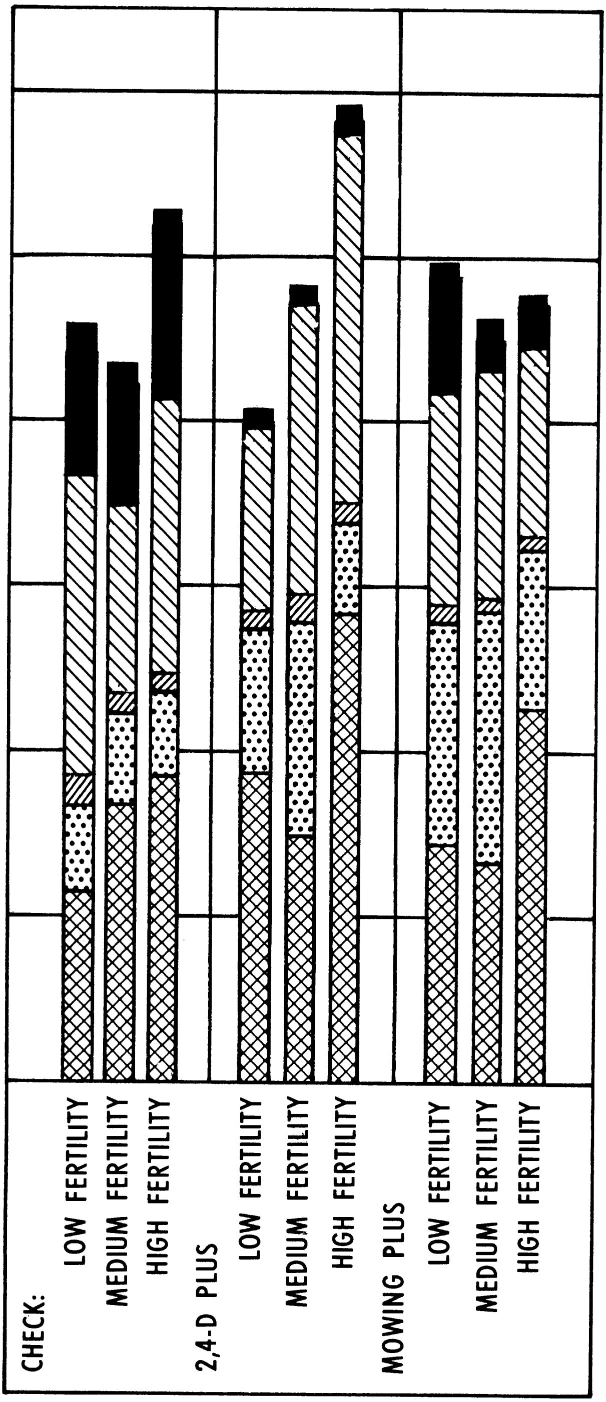


FIGURE 6.—Effects of 4 years of weed-control and fertility treatments on average annual production and consumption of various botanical components on Kentucky bluegrass pasture plots.

TABLE 5.—*Production and consumption per acre of various botanical components on plots plowed and planted to orchardgrass, 1963–66* [1]

Component	Production					Consumption				
	1963	1964	1965	1966	Average	1963	1964	1965	1966	Average
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Broadleaf weeds	0	0	201	534	184	0	0	30	20	12
Weed grasses	0	0	13	30	11	0	0	10	30	10
Legumes	0	0	40	215	64	0	0	36	200	59
Orchardgrass	5,654	2,690	2,850	4,567	3,940	5,064	2,380	2,790	4,100	3,583
Total	5,654	2,690	3,104	5,346	----	5,064	2,380	2,866	4,350	----

[1] Based on ovendried forage.

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FIGURE 7.—Relatively weed-free renovated plots of orchardgrass in August 1963 (top) and same plots in August 1966 (bottom).

SUMMARY

The purpose of this study was to evaluate the effects of 2,4-D and mowing, each combined with three fertilizer levels, on the botanical composition and desirable forage yields of a Kentucky bluegrass pasture.

Spraying with 2,4-D reduced lanceleaf ragweed (*Ambrosia bidentata* Michx.) populations to a greater extent than did mowing. Mowing had little effect on yarrow (*Achillea millefolium* L.) populations, but four annual sprayings reduced the yarrow population 66 percent. Spraying with 2,4-D for 3 years almost eliminated western ironweed (*Vernonia baldwini* Torr.) and mowing for 4 years reduced the number of ironweed stems 50 percent. Numbers of late eupatorium (*Eupatorium serotinum* Michx.) increased on all plots, but increased less on sprayed and least on mowed plots. Annual treatment with 2,4-D or mowing reduced or prevented seed production of broadleaf weeds so that annual weed populations were gradually reduced.

Plots with high-fertility treatments had fewer ragweed and yarrow plants than did plots with low- and medium-fertility treatments. As spraying or mowing decreased weed populations, the area occupied by legumes and desirable grasses tended to increase. Annual applications of phosphorus and potassium fertilizer (medium-fertility level) caused legume components in the forage to increase. Fertilization with annual applications of nitrogen, phosphorus, and potassium (high-fertility treatment) increased yields of Kentucky bluegrass (*Poa pratensis* L.) but decreased yields of legumes. Spraying with 1 pound per acre of 2,4-D amine injured hop clover (*Trifolium agrarium* L.) and lespedeza (*Lespedeza* spp.) to some extent, but because of reduction in broadleaf weeds, sprayed plots yielded significantly more legumes than did untreated plots.

Total consumption of forage was greater on plots receiving the high-fertility treatments than on plots receiving other fertility treatments, mainly because of the increased yield of Kentucky bluegrass. Combinations of high-fertility and 2,4-D treatments caused the highest consumption of forage on a Kentucky bluegrass pasture.

Plowing and seeding to orchardgrass (*Dactylis glomerata* L.) eliminated weeds for 2 years, but in 1965 the orchardgrass stand became thin and weeds became numerous. Orchardgrass and ladino clover (*Trifolium repens* L.) failed to become established in the spring of 1962 when they were planted, and 1 year's production was lost. Consumption on orchardgrass plots, if the year of no produc-

tion in 1962 is disregarded, averaged 3,896 pounds per acre per year compared with nearly 3,000 pounds on the bluegrass plots that received 2,4-D and the high-fertility treatment. These averages were about equal when we consider that failure to establish the orchard-grass and ladino clover mixture in 1962 resulted in a year's lost production.

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